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A MEMOIR *on the* CONSTRUCTION *of* SHIPS.

By Sir GEORGE SHEE, *Bart. M. R. I. A.*

ALLOW me to ſubmit to you a few thoughts on ſhip-building; a ſubject which, from its national importance, would ſeem to claim the attention of the moſt enlightened, but which has heretofore been conſidered by few, except mere mechanics. My motive for addreſſing you is to promote the public good; and as the remarks I ſhall make are more the reſult of obſervation and experiment than of ſcientific reſearch, I am perſuaded you will judge them with indulgence. I ſhould not indeed hazard them but upon the idea that great improvements in the arts have been ſuggeſted by perſons who were not artiſts, and that objects may ſometimes preſent themſelves in a more clear point of view to unprejudiced minds, than to minds much more informed when biaſſed by predilection for eſtabliſhed ſyſtems. Read Nov. 1, 1794.

I WAS firſt led to ſuſpect that the conſtruction of ſhips built in Europe admitted of improvement, by obſerving that veſſels employed on the river Ganges, and on different coaſts of India, carried great burdens in proportion to their dimenſions; and on examining them I found that, however widely they differed from each other in appearance, great expanſion was common to them all. In order to aſcertain their proportions I had exact models made of ſeveral of them, which I ſhall be happy to ſubmit to the inſpection of your Society. The veſſels of the Ganges, it is true, being conſtructed to move at times in ſhallow water, were not I found well calculated to ſail near the wind; but this defect I knew could be remedied; and it was ſufficient for my purpoſe to aſcertain the fact, that, when even heavily laden, they could be moved with greater velocity than veſſels on the European conſtruction, of the ſame burden, could be by an equal impulſe with ballaſt only on board.

The opinion I had thus formed was ſtrengthened in the courſe of a voyage from Bengal to England. Obſerving that the Rodney, a Company's ſhip, which I was on board of, appeared longer and ſailed faſter than other Indiamen, I made inquiry as to her conſtruction, and was informed that, on laying her keel, ſhe had been intended for a ſhip of much more conſiderable burden, but that, owing to a temporary ſcarcity of timber, all her dimenſions had been abridged, except that her length was ſuffered to remain, and conſequently to exceed by ſome feet the uſual proportion. On our arrival in the channel, with the wind about a point before the beam, we overtook a fleet of Weſt Indiamen, and we outſailed them with ſuch facility that they might almoſt have been ſuppoſed water-logged.

THESE obſervations, with many others, led me to beſtow more attention than I had before paid to an examination of the mechanical principles applied to the building of ſhips; and the more I extended my inquiries, the more I was convinced that their conſtruction was defective: Had, however, my concluſions not been ſtrengthened by previous obſervation, I ſhould not have obtruded them on your attention; for I am myſelf ſo much an infidel in theoretic ſyſtems in general, that I offer conſiderable violence to my mind whenever I ſubſcribe to their truth, unleſs confirmed by ſomething like experimental proof; and I ſhould not therefore expect from others much attention to remarks merely theoretic.

A GLARING defect in ſhips employed in tranſporting merchandize is, that they draw too much water, or are conſtructed too deep. It is well known that every floating body propelled, muſt, in its progreſs, diſplace a body of water equal in weight to itſelf, and in bulk to the part of it ſituated below the ſurface; and that this operation muſt be repeated ſo often as the body moved advances a diſtance equal to its own length. Now as the line of leaſt reſiſtance from the water diſplaced is upwards, it follows that the force neceſſary for its removal muſt be great in proportion to the diſtance of any part of it from the ſurface, and hence ariſes the facility with which veſſels drawing little water are moved, even when the burden they carry is conſiderable.

ANOTHER defect in merchant veſſels is, that they are too ſhort. The progreſs of a ſhip that wants length is impeded by perpetual aſcent and deſcent, even in water but moderately agitated; while one that has it proceeds with little more than direct motion. But this is not the only objection to want of length:—The tendency of the upper ſails of a ſhip is, not only to propel horizontally, but, in a very conſiderable degree, to preſs down the head and elevate the ſtern, as will appear evident when it is conſidered that the maſt is acted upon as a lever, the upper deck is the fulcrum, and the parts above and below it the two arms. Now the action of the wind that fills the upper ſails is nearly upon the point of the long arm, and the degree of reſiſtance to the depreſſing force ſo cauſed is determined by the length of the line from one extreme horizontal point of the ſhip to the other; when therefore this line is ſhort, in proportion to the height of the maſt, the effect is not only evident in a high or ripling ſea, with the wind fair and ſtrong, but even in ſmooth water, the veſſel, particularly if ſmall, proceeds with evident deviation from the horizontal poſition which her hull is intended to preſerve, as well when in motion as at anchor; and by this means the points of direct reſiſtance are multiplied, as the height of the frothy wave at the bows of ſuch veſſels in their progreſs, or the diſproportion of that wave to their velocity, ſhape and ſize, evidently ſhews.

A THIRD defect too, not leſs ſtriking than theſe, is that the veſſels I mention are too narrow. A few feet of length add little to the ſize of ſhips as to burden, but a ſingle foot in breadth increaſes prodigiouſly their capacity to ſuſtain weight. The ſhape of merchant veſſels in general may be ſaid, from its tendency, to reſemble an extended wedge perpendicularly placed; every ton additional weight preſſes them down conſiderably, and from the practice of overloading them, in order to proportion their burden to their ſailing charges and original coſt, they commonly proceed on a voyage almoſt buried in the water. To this circumſtance alone the loſs of numbers of them may be aſcribed; for a captain muſt be poſitive that the danger is exceſſive before he can hold himſelf juſtified in attempting to lighten the ſhip; and in ſituations the moſt perilous this is often found impracticable.

THE remedy for theſe defects is eaſily ſtated, but the practicability of applying it requires explanation, as inveterate prejudices in the minds of ſhip builders are to be oppoſed, and ſtrong prepoſſeſſions, in the minds even of men of ſcience who have thought mechanics deſerving their attention, to be combated.

To give ſhips great horizontal expanſion, in proportion to their depth, which I conceive eſſential to the perfection of their form, the conſtruction of their hulls, in other reſpects, muſt undergo a change. The bow and the ſide are, or rather ought to be, conſtructed upon principles directly oppoſite. The one is to break through the water, the other to reſiſt all force that gives the body of the veſſel a diſpoſition to lee-way. The perfection of the former is to have as few points of direct reſiſtance as poſſible, that of the latter, it would ſeem, to preſent as many; muſt it not then, to an unprejudiced obſerver, appear extraordinary that both parts ſhould be compoſed of ſegments of circles, ſcarcely a ſuperficial ſquare foot of the largeſt ſhip's ſide, below the water mark, lying perpendicular to horizontal preſſure. The keel, in fact, with ſome ſmall extent of plain immediately above it ſpringing from the bottom, are truſted to for reſiſtance, and theſe are in moſt caſes inſufficient, few veſſels, except frigates and others of extraordinary length, being found to ſail well upon a wind.

AN argument univerſally uſed by ſeamen and ſhip-builders, in ſupport of the preſent. conſtruction as to depth, is, that what they technically call " a gripe of the water below the power " of the ſurge," is eſſential in preventing veſſels from being driven to leeward.—As this argument, if ſound, ſtrikes directly at the root of any improved ſyſtem founded on expanſion, it is neceſſary that it ſhould not remain unanſwered.

A GRIPE below the influence of the ſurge, if it mean any thing, implies reſiſtance to the force of waves beating againſt a ſhip's ſide. Now ſuppoſing this reſiſtance poſſible, the firſt high ſea that ſhould ſtrike her on the beam, in a gale of wind, would inevitably either overſet her or deſtroy her by forcing in her ſide; the ſecurity therefore of ſhips, in numberleſs caſes that conſtantly occur, depends on their yielding to the force of waves. Admitting however, for argument-ſake, that, in ſtorms, the dexterity of ſeamen may prevent a ſhip from being expoſed to the violence of the ſea upon her broad ſide, let us ſee how, in moderate weather, the deep gripe can operate.

WAVES, I believe, are not thought to run very high when they riſe from ſix to ten feet above the water level; that is from twelve to twenty above the trough of the ſea:—there are few ſhips whoſe draught of water exceeds twenty; is it not evident then, that through all gradations of ſize, veſſels, even on their preſent conſtruction, are in general completely expoſed to the power of the ſurge.

BUT, as experiment ſuperſedes argument, any perſon in whoſe mind doubts exiſt upon this ſubject, may ſatisfy himſelf by viewing a ſmall cutter, when ſailing upon a wind, in company with large ſhips; or by obſerving a wherry, which draws ſtill leſs water, working to windward: Nay, even a ſhip's long-boat, the moſt flat of all ſea veſſels, may ſerve to convince him that he may diſmiſs thoſe doubts without running much riſk of falling into error, and ſatisfy him that, provided a veſſel have hold of the water proportionate to her ſize, it is of little moment whether the gripe be near to or remote from the ſurface.

THE improvements then which I beg leave to recommend in the conſtruction of merchant veſſels are, an increaſe of their horizontal, and a reduction of their perpendicular dimenſions, which will correct the three defects I have pointed out; alſo the alteration in the ſhape of their ſides and bows, which I have already ſaid is neceſſary, in order to render theſe improvements practicable.

WERE the length of the keel even ſo far extended as that it ſhould reach two perpendicular lines dropped from the extreme points of a ſhip's upper deck, the increaſe of gripe would be prodigious, and the additional expenſe trifling. A ſheer or projection abaft is unqueſtionably beautiful; but it is of no uſe, and the eye would ſoon become reconciled to an upright ſtern. The ſheer, however, might be given with any length of keel, where expenſe ſhould be diſregarded, unleſs it ſhould be thought, which I am rather inclined to believe, that a very long veſſel would be weakened by it, for the ſtrain upon a ſhip's centre is in fact reſiſted more by the binding of her upper planks and timbers than by the ſtrength of her keel. The expenſe of this increaſe of length, together with that attending the increaſed breadth of the veſſel, would nearly be paid by the ſaving cauſed by the reduction of her depth.

THE alteration in the form of the ſides and bows needs a few words more of explanation.

THE effect to be expected from a flat ſide is exemplified in an ingenious contrivance uſed to ſupply want of depth in Dutch veſſels of various deſcriptions; and I cannot give a more correct idea of the improvement in this reſpect I wiſh to recommend, than by ſaying that the ſide of a ſhip, below the water level, or a part of it at leaſt, ought to reſemble a *lee board* of conſiderable extent. By means of this board many Dutch merchant veſſels, notwithſtanding they are conſtructed with a floor almoſt flat to fit them for great burden and ſhallow water, are found to ſail tolerably well upon a wind, and yet they are in general ſhort, with bluff upright bows, and many other defects.

Dutch fiſhing veſſels too, particularly thoſe employed in great numbers on the coaſt of England, are rendered by the uſe of a lee board good ſailers. Not being intended for burden they do not in general much exceed boat ſize; and although they are the moſt flat of all decked veſſels I have ſeen, their ſecurity in blowing weather is proverbial.

Now in reſpect to the bows of merchant ſhips, I will only obſerve, that although they ſlope off tolerably well when veſſels are light, they preſent, when laden, ſuch reſiſtance to head way as can ſcarcely be overcome by any preſſure of ſail. The evident remedy is to render them leſs upright; expanſion in them, although abſolutely neceſſary above the water level, being quite uſeleſs below it.

By adopting theſe improvements I am perſuaded that the ſame quantity of timber and other materials now employed in building a merchant veſſel of one hundred tons burden, would ſerve to form one capable of carrying at leaſt one hundred and thirty, and that the velocity gained would rather exceed this proportion. The advantage of performing three voyages in the uſual time of two, or even ſuppoſe five in the time of four, need not be ſtated; nor need that which would reſult, in the ſeaſon of tempeſt, from reducing the length of time in which ſhips are expoſed to danger, or in time of war from rendering them capable of evading purſuit.

THE conſtruction of veſſels employed in carrying mails between Dublin and Holyhead I conceive to be nearly as defective as that of merchant ſhips, which their hulls in a great meaſure reſemble, although they are built expreſsly for ſpeed and accommodation, and not burden. But indeed burden they do carry; for, from their deep form, they require an abſolute loading of ballaſt to prevent them from overſetting; and their draught of water is ſuch, although ſmall veſſels, that they can float on the Dublin Bar only at a particular time of tide, by which fair winds are frequently miſſed, and the paſſage from England unneceſſarily prolonged. From their want of length and exceſſive depth they are ſuch ſlow ſailers, that the Favourite, a light long veſſel, fitted out by private individuals, has made her paſſage to Holyhead in nine hours, when two packets, which weighed anchor when ſhe did, took twelve to perform theirs.

IN determining the moſt proper conſtruction for theſe, or indeed any other ſea veſſels, it ſhould be conſidered that the greater the length the leſs depth will be neceſſary to prevent lee way; and that the greater the breadth, the more ſail may be carried, and the leſs ballaſt required. Weight it is true does not operate exactly upon ſhips as burden does upon animals; its ſituation, as I have already ſaid, determining in a great meaſure the reſiſtance to velocity it cauſes; but that its operation is conſiderable cannot I believe be doubted. In ſhort, I am perſuaded that packet veſſels might be conſtructed on a principle ſo light, that they might paſs the Dublin Bar at any time of tide, ſo ſpeedy, that they would commonly perform their voyage in three-fourths or perhaps two-thirds of the time thoſe in uſe now employ; and at the ſame time that they would, if poſſible, be more ſafe, and certainly much more commodious, their building and ſailing charges would not be more conſiderable.

To determine the exact extent to which the improvements I recommend can, in general, be practically applied, is not my preſent object. I only mean to ſuggeſt hints which, if thought deſerving of the trouble, may eaſily be thrown into regular ſyſtem; and I will cloſe an addreſs, imperceptibly extended beyond its intended limits, with a word on ſhips of war.

SHOULD theſe improvements prove founded on true principles of naval architecture, their application may certainly be extended to the conſtruction of frigates and all other King's ſhips carrying one tier of guns only; but that thoſe of two and three tier can, in an equal degree, be improved, is an aſſertion I will not hazard. The effect of the weight the latter carry above water muſt be counteracted by a proportionate weight below it, and it is poſſible that an increaſe of their horizontal expanſion would be unſafe, conſidering that timber beyond the preſent dimenſions cannot well be procured. Determinate flatneſs of ſide, however, for ſome diſtance below the ſurface of the water, would aid very conſiderably in reſiſting the effect of a ſide wind on ſo prodigious a ſurface as their hulls preſent above water, and even a very trifling addition to their breadth of beam would probably enable them to carry their guns better than they now do in a high ſea, and render ſome reduction of their draught of water practicable.

THAT light frigates might be made capable of receiving as great velocity from a moderate breeze as is now given them by a ſtrong wind, is a truth I am perſuaded of; and that the utmoſt velocity any veſſels are capable of is not yet attained in the European ſeas, is a fact that will not be doubted by any perſon who credits the well authenticated accounts given of flying prows. The form of theſe veſſels it is true unfits them for any other ſea but that in the latitude of the Ladrone Iſlands, but uſeful hints may notwithſtanding be taken from their conſtruction.